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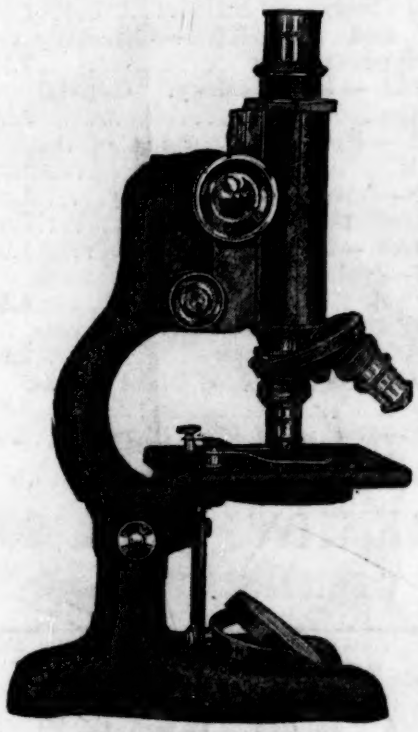

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SOME RESPONSIBILITIES OF BOTANICAL SCIENCE[1]

WHEN this meeting of the American Association for the Advancement of Science was first announced it was the expectation of all of us that our discussions and deliberations here would center primarily about the immediate and practical needs of a time of war. In those days the thought seemed common in this country, that it was the plain duty of scientists to lay their more remote aims aside for the time being and to devote their energies almost entirely to practicalities, the practicalities of those great martial undertakings whose wonderfully successful results have only just now passed into history. But it has become clear that the needs of a modern militant nation are not merely men and money; the ramifications of these needs seem to have led into nearly every cranny of human activity, so that almost every person has found ways by which his special fitness, for some activities rather than for others, might be utilized in this grand mobilization of the nation as a whole. In very many cases it has appeared that the more remote aims of those whose activities are primarily intellectual and spiritual are not to be laid wholly aside at the sounding of the trumpet of war and at the waving of the battle flag. It has emerged that most or all of those activities that may truthfully be called essential for peace and for the general advancement, are also essential in time of war. Details have required alteration, but the war has led, on the whole, rather to an acceleration, to a speeding-up of the majority of productive peace activities, rather than to the laying of such activities aside.

War differs from peace rather in degree than

[1] Address of the chairman and vice-president of Section G—Botany, American Association for the Advancement of Science, Baltimore, December, 1918.

in kind. It calls for a mobilization—which is a planned cooperation—of all the valuable and worthy activities of the nation. And just such a mobilization was proceeding with ever-increasing strides in this country, until the news of the present armistice announced the need for still further changes of detail. Let us hope that the spirit of planned activity, aroused from the magic lamp of human nature by the rubbing of a martial hand, may not be sent to rest with the return of peace. The civilized world has found again that the greatest human pleasures and satisfactions may come from the giving of money and goods and heartbeats and even the life-blood of many individuals, all for the furthering of the same worthy cause. It has found that national and world mobilization are the means whereby great works may be rapidly achieved, it has found that cooperation between individuals and between states is the means whereby the pleasures of the accomplishment of such works are to be most quickly attained. In order that we and those who follow us may enjoy these great pleasures of accomplishment, let us strive to keep the spirit of cooperation alive and aggressively active against the false demons of the more primitive and more frequently prevailing forms of selfishness, and let us move forward, with this spirit in our hearts, into the era that is now dawning.

The burden of my words to you this afternoon will be to ask you to pass, for a few minutes, out of the work-a-day world of selfish struggles for "credit" or "priority" in scientific literature, or for salary increase and the like of that, out of the world of minute detail with its microscope lenses and balance pans, and to dwell for a little while on some of the larger possibilities and opportunities that lie before botanical science at this time. And I shall wish to emphasize the idea that, for a goodly number of us, at any rate, these possibilities and opportunities are tasks and responsibilities that really and truly need to be met.

It is well first to realize that those who devote their lives to science have peculiar responsibilities. The body of human knowledge has grown apace and constitutes our most cherished possession. It alone can be handed on to the coming generations; other human achievements wear out and disintegrate with time, while knowledge lasts and grows and increases in value as our race matures. Whatever may be your idea of the final good of human life, whether it be to glorify God or wallop the devil, to give ourselves pleasure in the present or in the future, or to give to coming generations a better chance to live as they will wish to live—no matter at what particular angle you may view these academic questions of ultimate results, you will surely agree that the preservation of real knowledge is one of our responsibilities. We and our posterity will have great need for all the knowledge that is available, to-morrow and the day after, and one of our world responsibilities is clearly to see that knowledge once gained shall not be lost.

But this is not all. It is not sufficient for a healthy human being to act merely as a vestal, simply to keep a torch burning that was kindled by others. It is our instinct to increase the body of science as well as to preserve what has been accomplished, and instinct appears to accord with reason here, for if knowledge is valuable it should be increased as rapidly as possible. This is, then, another of our world-responsibilities.

To preserve for the future all that is known of ourselves and of the universe about us, to make this knowledge ever more readily available, and to add to the store as we work it over and hand it on to others, these seem to be the prime responsibilities of human beings, as distinguished from other organisms. Now, if these things are to be done there is no group of society so fitted to do them as is the group of scientists; upon them has fallen the mantle of the vestal and that of the priest. Society, as a whole, relies on scientists for these things and these responsibilities are especially ours.

It has frequently seemed to me that we, as a group, fulfill these requirements with a maximum of friction and waste and with a minimum of efficiency. At least it is not difficult for a dreamer or an idealist to suggest general

ways by which our service to humanity might be greatly enhanced. If improvements might be introduced each individual might find more pleasure than is now possible, in his own work and in that of the group, and it seems just now to be an opportune time to take some thought as to possible ways by which our social function as scientists may become more satisfactory, both to ourselves and to those outside of our group. A kind of idealism has succeeded in winning the war, and he who runs may read that this was a war of science, and that it was through science that it was finally won. Consequently, I may not be too bold if I here pass in review some of the suggestions for an improved science that have come to me in one way or another.

In the first place, ever since my student days it has seemed very strange to me that the devotees of science lay so little stress on the broader and more general aspects of their work and upon the aims that are held in view. Our introductory books plunge the beginner into a maze of concrete detail, without attending to the orientation that every beginner needs. Our teaching of beginners follows our texts, or else our texts follow our teaching. We imply that this general orientation, this appreciation of the relations between our particular small chapter of science and the great body of human knowledge, will care for itself, without conscious attention. We see that our students learn how to weigh a seed or how to stain a chromosome, and we strive to give them a digest of all that is so far known of seeds or chromosomes, but it is only seldom that the very need for such knowledge receives adequate attention. I am not sure whether botanical science is to be criticized more in this respect than other branches, but I am sure that the criticism is justly to be considered by botanists of all sorts.

Obviously the matter has lain largely in a lack of *esprit du corps* among botanists; we have largely failed to be conscious of our responsibility as a group. We have not taken the trouble to find out what we can agree on, and an outsider feels that we can not agree on anything at all. As the late Professor Bessey remarked of botanical research, the work of botanical science is carried on by a sort of guerilla warfare, each botanist for himself. To speed up our work in all lines we need more team-play, as it were. We need to have somewhat clearly in mind what, indeed, our activities are all about. If we might attend to these matters of orientation we ought to be able, then, to emphasize certain sorts of work that are to be regarded as the more important, for the present.

The answer to the question as to how guerilla warfare, without *esprit du corps* and without conscious aims, is to be metamorphosed into a planned and productive campaign, lies, I am almost certain, in the connotation of the word cooperation. As we mobilized ourselves and laid aside our individual differences of opinion or faith, in order to help in the winning of the war, even so (if we thought it important enough) we might mobilize ourselves for the rational acceleration of the work of botanical and other sciences. One of our greatest responsibilities right now is to orient ourselves as a group and to plan our campaign of work for the immediate future.

The group of botanists is an international group and our mobilization should aim to be international finally, but it were well if the botanists of this country might put their own house in order as a first move toward the setting up of conscious aims and planned campaigns by the world group. In the meantime, botanical scientists of other countries may be doing likewise, and the International Association, or some other organization, might become the means of bringing the national groups into a single whole.

Turning to matters a little more concrete, I suggest that there are two quite different kinds of aims or objects, toward which we may strive. The first of these has to do with our responsibility to *preserve* botanical knowledge, to make it available for all sorts of application, and to pass it on to the next and later generations. The second kind of aim deals with our responsibility, to *add to* botan-

ical knowledge. I should like to consider certain ideas with reference to each of these two general aims.

The Conservation of Knowledge Already Attained.—My first topic, on the conservation and presentation of knowledge already at hand, involves the teaching of students and the publishing of résumés, year-books, abstract journals, and the like. The teaching aspect I shall not venture to take up here; the atmosphere is at present somewhat hazy with discussions on botanical, zoological and biological teaching, questionnaires on these topics flit frequently through the mails, and this whole matter seems to be receiving considerable attention at the hands of teaching botanists. Also, it seems well for your vice-president to take no sides on these questions at present, especially as he does not count himself a teacher (excepting for the purposes of army draft questionnaires!) and has not taught beginners for many years.

On the other hand, I do wish to ask your consideration of several ideas bearing on the preservation of botanical knowledge and the rendering of it available to those who wish to use it in some way. You have all appreciated the fact that the storing and handling of scientific knowledge (as represented by the literature, and to some extent by herbarium and museum specimens) has recently become of the utmost importance. Botanical science is now so broad, and its wealth of knowledge is so great, that no worker can hope to read nearly all the papers appearing in his own field, to say nothing of those in related fields. It thus comes about that valuable bits of knowledge get lost in the pile, as it were, and fail to reach those persons who would be able to use them. It is a favorite "indoor sport" for scientists to find fault with their colleagues because the latter are not suitably familiar with the literature, but the critic is generally as lame as the poor cripple he derides. As I have remarked elsewhere, "science is in great danger of obliterating itself under its own productions, poisoning itself with its own excretions, like yeast." It is a very serious research to find out what is already known about any given topic, and matters grow daily worse.

Abstract journals can help greatly in this difficulty, and we are trying to improve conditions by starting *Botanical Abstracts,* an enterprise that is a cooperation of a large number of workers in botanical science "in its broadest sense." Some botanical journals, like the *Revue générale de Botanique* and the *Plant World,* occasionally publish résumés of the present status of knowledge regarding some limited topic. These are of great value if accompanied by accurate citations, and their number should be increased. Sometimes journals publish monographs more complete than résumés; for example, Jörgensen and Stiles' monograph on "Carbon Assimilation," which appeared in the *New Phytologist.* Such contributions should be encouraged, especially when they represent the cooperation of a number of workers and are accompanied by full and accurate citations. But, from apparently authoritative discussions of the status of a scientific field, by a single author and without citations of the literature, may whatever gods there be left deliver us!

But it needs to be emphasized that all these things are but makeshifts. We need to step forward boldly and state that our science, as well as all the others, needs, and needs very much, a *national or international institute for the furnishing of bibliographical information on request.* Such an institute would of course be a great undertaking, even for a field as narrow as botanical science, but it might well be the most productive investment that science (or humanity as a whole, even) could now make. It has been suggested that the establishment of such an institute for this country might well be by the National Research Council (which has been made permanent as you know), under the auspices of the National Academy of Sciences. And it has also been suggested that this proposed institute become the avatar of all those vague longings that find voice from time to time in pleas for a national university of some sort. Such an institute would have its permanent staff of departmental heads and its corps of

bibliographical assistants, but it would seek to have the full cooperation of all scientists. It would undertake to furnish bibliographies on any topic, with or without abstracts, and within reasonable time. I suspect that an organization of this kind might pay a good portion of its current expenses, through fees charged for the work done.— I might follow this dream into further detail, but I imagine the time is not yet ripe for that, what I wish to do here is to leave you with a very clear impression that this suggestion has great promise, that it is quite within the realm of possibility, and that it may ultimately be realized if we can unite in calling for it. It would avoid enormous wastes of time and energy on the part of many scientific workers and research institutions, and it would give congenial and dignified employment to many who wish to serve in scientific work but who may not find their best places as teachers or research workers.

Botanical Research.—Regarding research itself, and how we may best mobilize our limited strength so as to accelerate the advance of knowledge as much as may be, I shall confine my suggestions to three general topics: (*a*) the planning of research, (*b*) the procuring of data, and (*c*) the interpretation and presentation of results. But before we turn to the consideration of such suggestions as I may offer here, I ask your attention to two very striking characteristics of scientific research in general. First, scientific research is not recognized as an occupation or profession. We speak of research workers and emphasize the great value of their work to mankind, but the draft questionnaire (presumably the result of a number of able minds attempting to classify the possible occupations of our citizens) failed to show any such occupation. You might be a farmer or a blacksmith or a chauffeur, you might be a lawyer or a physician or a preacher, but you could not legally be a research worker or scientific investigator! An investigator in physiology might call himself a *teacher*—for he surely has to tell others about his findings —but this was misleading unless an explanation was made. On the other hand, he might call himself an agricultural worker, engaged in an agricultural enterprise—since his physiological studies may frequently have something to do with agricultural plants—but this also was misleading and suggested familiarity with plows and manure-forks rather than with laboratory apparatus of precision.

My reason for introducing this somewhat startling observation is to call attention to the fact that scientific research is unorganized and unrecognized as a reputable occupation. Galileo had to steal away and perform his experiments in secret, on account of a devilishly inquisitive church, Leonardo had to get time for his researches between trips to the ducal palace to do odd jobs of repairing the plumbing and such-like things, and it appears that modern science has left this whole matter of research in much the same condition as that in which it was in those old times. A teacher may obtain some time for research between elementary classes in arithmetic or agronomy, a lawyer may carry on research on Sundays and holidays, but you must admit that, for the most part, scientific research is left to individual activity and is not sufficiently recognized to warrant official mention!

This is the more notable when we recall that the educational aspect of scientific responsibility is very thoroughly organized and largely standardized, with great government support of many kinds and with enormous endowments supporting libraries, museums, lectures. We have public recognition of the fact that knowledge is to be carefully preserved and passed on in available form to coming generations, but it is not as yet practically recognized that it is anybody's main business in life to increase knowledge through investigation.—It is a noteworthy fact that research is frequently expected of college and university teachers, that they are frequently appointed on the basis of published papers presenting the results of research, and it is just as noteworthy that such a teacher must generally carry on his investigations in a surreptitious way; his teaching activities are recognized but his research activities are not, even though their

results are expected and even demanded. In purchasing laboratory equipment for research it has indeed happened sometimes,—so I am told,—that research apparatus has been purchased under the false pretense that it was needed in teaching! If botanical research is one of our responsibilities as botanists, I submit that this anomaly demands some serious attention.

The other striking characteristic of much of our scientific research is this, that most of the published work appears to be done by *apprentices*. I refer to publications by beginners, like dissertations for the doctorate of philosophy in our universities. I can think of no other line of important human activity in which the work of apprentices looms so large as it does in botanical and other sciences. This state of affairs would not be so bad if the leaders under whose guidance the work has been done could take enough part in it to save the publications from the verge of futility. As would be expected of apprentice work, these publications frequently show poor planning and more frequently poor interpretation. The gathering of data may be well done, within the limits set by the plans. There seem to be some possible ways out of this difficulty, but I shall not take time here to mention even the ones I have had in mind.—I turn now to my three phases or aspects of research.

(*a*) *The Planning of Research.*—It has seemed to me that the planning of scientific investigation deserves very much more attention than it generally receives. Not having any clear aims, we are apt to be misled to the erroneous idea that all sorts of research are of equal importance. Perhaps it is not any longer fashionable to tell students that the mere gathering of facts in *any* field constitutes valuable scientific work, but we surely have not passed far beyond the conception that a personal and capricious interest is a proper and respectable guide in the choosing of a problem and in determining how it is to be carried out. It often seems that each worker brings forward his contributions without any notion as to how they are to fit into the structure of the science as a whole. It is somewhat as though each of us brought what he happened to have and threw it on a large and heterogeneous pile, hoping that a rational structure might, by some unknown means, be builded therefrom. We seem to feel little or no responsibility in the building itself, we bring contributions that can not be used at present and we let the building operations stop at many points because we do not bring the materials that are immediately needed.

A well-selected problem does not always mean a well-planned investigation, however; and an opportune problem has often led to great waste of time and work simply because the method of attack was hurriedly decided upon. As you have surely observed, experimental and observational investigation, as it is published, frequently shows what almost seems to be a genius for omitting the needed experimental controls. Again, things that are of relatively small importance are often dwelt on with great care, while the most outstanding points are woefully neglected. Needs that should have been cared for in the preliminary plan are often not appreciated until the experimental or observational work is completed, when it is too late to mend matters.

I have been led to think that this condition of affairs is largely due to a still more or less prevalent and very insidious fallacy, to the effect that a scientific investigator can not hope to find out what he sets out to find out, but has to drift with winds and currents and gather in the observations and results that he happens to run across. It is sometimes the business of a pioneer explorer to work in this way, but I think we should hardly call that sort of work scientific research in the modern sense. Discoveries of *facts* may be made now and then by chance and intuition, but discoveries of *relations* (with which our science now mostly deals) are largely to be made by taking serious thought as to just what we need to do in order to find out just what we set about finding out.

You have been warned earlier in this address of the fact that I regard cooperation as the touchstone by which we may hope to cure,

or at least alleviate, many of our scientific ills, and you will at once see that our selection of problems and our planning of projected investigations would be greatly improved if cooperation between competent thinkers were more in vogue. If every projected research involving considerable expenditure of money and energy might be submitted to several competent workers, with the request that they make suggestions, I have no doubt that much more valuable and feasible plans might result. It strikes one as a curious fact that scientific investigators wish to keep their work secret until it is finished (as they may fondly suppose), after which they are just as strong in their wish to present it to their colleagues. The results of investigation are frequently treated like Christmas gifts; they are planned and made in secret and handed to the recipients only after alterations are well-nigh impossible! And, finally, to complete the anomaly, the investigator is often sorely pained if his contribution proves to be very imperfect or even quite unacceptable! One wishes to ask why it would not be better to obtain the adverse criticism *before* the work was "finished," rather than to wait until after publication; the criticism will eventually be forthcoming in any event and it should be much more useful if it were made available early in the investigation. In so far as in us lies, we should avoid wasting our own time and facilities and those of our colleagues.

As I have emphasized elsewhere, it ought to be of enormous value to botanical science if some organization (perhaps the National Research Council) might publish yearly a list of what seem to be important and promising and feasible problems for botanical investigation, with elaborated plans. My imagination pictures this list as rather long, including all sorts of projects, sent in by numerous thinkers who have the well-being of their science really at heart, and I should expect it to alter from year to year, as projects get undertaken and results are obtained. It would be a fine thing if each society of research workers were to take upon itself the responsibility of furnishing such a series of proposals. This should be accompanied by a usable bibliography of each problem, and mention should be made of investigators who might be engaged in this sort of work.

If this dream might come true such an annual publication might do more toward giving us a rather clear picture of the aims and trend of our science than could be secured from any other simple form of organized cooperative effort.

(*b*) *The Procuring of Data.*—After a research problem has been selected and properly planned, the securing of the requisite observational or experimental data is a matter of comparatively little difficulty. This is the easiest part of investigation and many publications consist of but little more than tabulations or lists of the data secured, without serious attempt to exhibit either plan or interpretation. This phase of research requires special attention less than do the other two and I need not dwell here upon it. I may suggest, however, that when practical difficulties arise during the progress of a piece of experimental or observational work, it would be well for the investigator to call upon some of his competent colleagues for advice, and it would also be well for the rapid advance of our science if the persons thus asked might respond in a wholehearted sort of way. Let it be remembered in this connection that botany is a world science and that its advance is not to be accelerated through the usual operation of institutional or individual rivalries and jealousies. Such motives may have value if rationally controlled, but they do not appear generally to result in the building up of an *esprit du corps* among scientists.

(*c*) *The Interpretation and Presentation of Results.*—It frequently follows that a good plan systematically carried out gives results that are largely interpreted by the plan itself. If a quarryman cuts an ashlar expressly for a certain position in a wall it is not necessary for him to explain to the builder just what is to be done with it when it is delivered. But the case is not nearly always so simple as this when complicated problems are under investigation. And most biological problems are still

so complicated (largely because they are chosen to embrace too large a field in each case) that special effort is required to find out what may be the meanings of the data at hand.

It appears that comparatively few writers take the trouble to interpret their results in anything like a logically complete manner. Our interpretations are generally hurried and are apt to be biased. Out of a large number of logically possible conclusions we are apt to state but one and to pretend that the facts support this hypothesis more than the others. Indeed, we usually write our discussion from the standpoint of a single one out of several or many logically possible hypotheses. The general result is that our literature abounds in published data which are either uninterpreted or illogically or incompletely interpreted. One of the greatest wastes in biological research lies, to my mind, in the publication of so many uninterpreted observations. To the beginner in research it may seem that a grateful science should be willing to interpret these data if the writer will just present them, but this is found not to occur in practise. As a general rule, if an author does not interpret his own results they remain uninterpreted and are finally lost in the maze of the literature; most active investigators do not like to attempt the study of the logical possibilities suggested by results obtained by some one else, especially as the plan followed in obtaining such results is apt to have been different from what the second investigator might wish to employ. It were better if we performed far fewer experiments and devoted much more time and energy and care to logical planning and thorough interpretations of the results we secure.

Just as in the case of choosing and planning an investigation, so in the case of interpreting observational and experimental data, several brains are preferable to one, and cooperation is greatly to be desired. It seems highly desirable, indeed, that several competent minds might be asked to make suggestions regarding any research, at several times, from its inception to the publication of the resulting contribution. If some of our critics might be asked to criticize our papers before they are published, a great many mistakes and misunderstandings might be avoided and a good deal of personal jealousy and righteous or unrighteous indignation—both of which waste energy and time and money—might be prevented. Some of the standing committees of the Ecological Society of America have arranged for this sort of pre-publication criticism and it promises to be a valuable feature in raising the standard of research publication.

Responsibilities toward Applied Botanical Science.—In working over the mass of botanical knowledge that has already been obtained, for the purpose of presenting it to others, and also in selecting lines along which research is to be undertaken, we shall fail very seriously in the discharge of our responsibility unless we give special attention to the scientific and philosophical aspects of the application of our science to all the various needs of man. In a former publication[2] I have emphasized the fact that what is now commonly called applied science does not include nearly all of the applications of scientific knowledge. I take it that the term applied botany means to most of us *practical* applications in the arts, which serve the physical, esthetic and even the spiritual needs of mankind. Here belong agriculture, forestry, pharmacognosy, floriculture, such arts as dyeing, tanning, spinning, cooking, brewing (I believe there are still breweries somewhere in the world!), and many other important branches of human activity. These may be called practical applications, because they supply material things that are in demand and consequently have pronounced commercial value.

But there is another kind of application that is very important but that may not properly be called practical. I mean those applications that satisfy the intellectual or mental needs of mankind. Thus, chemistry, physics and climatology are applied in botanical science, and this science is in turn applied in chemistry, climatology, geology, psychology, philosophy, and so forth. In default of a better term I may call these *philosophical* applications. Here also belong the applications of one branch of our science to another branch, as

[2] Johns Hopkins University Circular, March, 1917.

when anatomy is applied in physiology, or when physiology is applied in ecology. While the philosophical applications of botany do not "take the eye and have the price" as do its practical applications, yet their value is universally acknowledged to be exceedingly great. They should not be left out of account in our proposals for a renewed mobilization of botanical scientists.

A consideration of these two groups of applications, called here the practical and the philosophical, will furnish a wealth of suggestions for research projects. It is the business of botanical scientists to supply all knowledge about plants that may be enquired for in behalf of any line of human activity. If we do not possess a certain kind of knowledge demanded by an art or another science, surely it is our responsibility to make the needed knowledge by research, and to do so as promptly after the need arises as is possible. Looked at in this way, the prevalent conception of botany as a composite of two different kinds of science, "pure" and "applied," is seen to strike very wide of the mark. In many ways it is to be regretted that many arts that employ applied science have come to be themselves called sciences, thus creating great confusion, but it were hopeless to try now to correct such illogical usages as those of agricultural science, medical science, veterinary science and the like. Agriculture, for example, is not a science, but an art, and whatever of science it employs is applied from botany, zoology, geology, climatology and so forth. (Of course it is understood that if plant physiology or the physiology of the wheat plant is regarded as a part of botany, so must animal physiology and the physiology of man be considered as a part of zoology.)

We are probably all in agreement as to the proposition that by far the greater portion of future botanical investigation will have to do with supplying botanical knowledge to the arts of agriculture, forestry and medicine—and the greatest of these is agriculture. Other speakers at these meeting will probably emphasize the scientific needs of this art—which they may call a science—and I need not here go farther in this connection.

If you agree with me that some of our greatest responsibilities have to do with the supplying of knowledge needed by the arts and the other sciences, and if you also agree that much of our advance is to come through cooperation, it naturally follows that botanical scientists must cooperate not only among themselves but also with workers in other sciences and in the arts.

In conclusion of this address, which may already be too long, I shall not attempt to summarize the various points and suggestions to a somewhat awkward presentation of which you have so kindly and patiently listened. I have voiced a longing for a conscious cooperation among scientists that has been felt by all of us, and I have placed before you a few suggestions as to some paths along which we may hope to proceed toward the realization of this desire. This address lays no claim to logical completeness but I think I may claim for it that it is facing in the right direction. We surely need to appreciate our responsibilities as botanists toward humanity and to take conscious steps toward the organization of rational compaigns against the demons of ignorance and superstition and waste. Now is the time of times, the "zero hour"; let us assume our responsibilities and do our share in the reorganization of human life for the new day that approaches. And let us not get in each other's way nor in the way of other groups of workers. We would give once again to botanical science her "place in the sun," but we would not do this by interposing any hindrances in the paths of the other sciences, with which we have no quarrels. Finally, we would accelerate the growth and unification and organization of our national science, not that we may excel in a national way (with a sort of colossal selfishness of an all-too-common type), but that we may serve world science to our utmost, thus gaining the supreme satisfaction of having appreciated our responsibilities and borne them in such manner as to receive, at last, our own approval.

BURTON EDWARD LIVINGSTON

THE JOHNS HOPKINS UNIVERSITY

INDUSTRIAL RESEARCH IN ONTARIO AND PRUSSIA COMPARED

Those who treat lightly the industrial research of this continent and lavish overdue praise on the research of Germany do not use a standard of measurement—a unit of population in the present case—for the comparison, which through the omission becomes a mere arbitrary opinion. A common example of this laxity is the remark of one who was speaking of the United States and Canada: "Progress along advanced industrial lines has not hitherto paralleled that of Germany." Scrutiny of the statements of such writers on industrial research always fails to show any trace of a standard used in their comparisons, and it is with a view to supply what they omit that the following particulars are compiled:

In 1909 the Ontario government commissioned Dr. John Seath to report upon industrial education, and the report he submitted ("Education for Industrial Purposes"), bearing date 1911, contains some of the latest statistics on technical education before the war, and also contains incidentally some information on the allied subject of industrial research. In particular, he gives a list (p. 161) of the thirty-three technical "schools" of university rank in Prussia which are in a position to undertake research work. This list for Prussia has more details than the similar list in the "Encyclopædia Britannica" (1910–11), which relates to the whole of Germany. The Prussian list consists of the following: nine technical schools, or polytechnica, of which the one at Charlottenburg is the chief example; three mining academies; five forest academies; four agricultural academies; five veterinary "high schools"; five commercial "high schools"; two schools of art.

Junior industrial schools and technical schools of the middle class, the former with state contributions of 38 per cent., the latter with 54 per cent., were educational, not research institutions, and did little work in research, compared with those of university rank given above. If, therefore, we add to this list of 33, the nine medical schools, which are connected with universities in Prussia, and which are doing the public laboratory work—omitting the literary faculties of law, divinity and philosophy in the universities, which are negligible in an enquiry relating to science—we get a complete census of the 42 Prussian institutions that do advanced research work. On a basis of population of 42 millions then in Prussia, we find one such institution for every million people.

Next, consider the case of Ontario, where, as in Prussia, such institutions are mainly provincial or state, and not federal. Following the same order, Ontario has: two schools of applied science and engineering ("polytechnica"); two mining schools doing assay work for the mining industries; one forestry school; one agricultural college at Guelph, doing research for the past forty years (the Ottawa college being federal). The bulletins and reports from Guelph have numbered several thousands. One veterinary college, established in 1862 as a private enterprise when there were very few on this continent, and taken over by the government of Ontario in 1908. Three laboratories, the central at Toronto, with branches at Kingston and London, Ontario, viz., one at each medical college, doing public analysis like those of the Prussian medical colleges. (The federal laboratory at Ottawa deals with adulterations.) One meteorological research observatory for industries, and especially for agriculture and the shipping industries. It is now supported by federal funds but was originally a local institution in Toronto. (The agricultural academies attend to this line of research in Prussia, the meteorological institute in Berlin being mainly a collecting point.)

This aggregate of eleven government institutions of research for the industries of Ontario, on the basis of two and three quarter millions of population at the outbreak of the war, makes a total of four per million people, or four times the number in Prussia for the same unit of population (one million). In making this comparison where the number of institutions of research for the industries is the criterion, there is no separation of research for specific problems from research for

the general benefit of industries, as the two are so closely associated.

Comparisons of data on the numbers of officials and instructors employed, students trained (where it is a teaching institution), and public money expended, when referred to a population basis, would reveal for Ontario, if space warranted their publication, similar favorable results. And it would be easy to cite other provinces and states on this continent comparing favorably with Prussia.

It is not difficult to understand why the faith in German and Prussian "greatness" in research has become so general in America, as it was the privilege of the Germans themselves, as usual, to bell the cat. In November, 1915, a debate took place in the Reichstag over the spending of 40,000,000 marks in propagandist work in the United States of America, and a socialist member asked what good they had received from it. The outlay involved liberal sums for illustrated articles on the industrial training institutions of Germany, inserted in United States illustrated journals which circulate also in Canada. While the propagandists knew the value of advertising, many who read the articles and still derive their arguments from them failed to understand that it was advertising matter. Whatever progress Germany made was due to the application of science to the industries, and no right-minded person would begrudge them peaceable success, if their international politics had been just.

It is not surprising to find that research had been along different lines in Prussia and in Ontario, their material being received here in exchange mostly for well-developed agricultural products. The war changed this, and in a propaganda of the manufacturing classes to throw the burden of research upon the public, paid for out of the public treasuries, it is well to bear in mind the reasonable plan adopted in England of granting a pound of government aid for every pound expended by private enterprise.

A. F. HUNTER

NORMAL SCHOOL BUILDING,
TORONTO

SCIENTIFIC EVENTS

THE LONDON IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

WE learn from the London *Times* that past and present students of the Imperial College of Science and Technology at a mass meeting in the Imperial College Union, on January 29, decided, with only one dissentient, to sign a petition urging the governors of the college to take immediate steps to raise the status of the college to that of a university of technology, distinct from the University of London, and empowered to confer its own degrees in science and technology.

The petition expressed the opinion that the recognition of the Imperial College as an institution of university rank should be one of the earliest items in the program of legislative reconstruction, and that his majesty's government should give every encouragement to students who desire to devote their lives to science and technology.

Mr. Herbert Wright, one of the governors of the college and a past student, who presided, said they were concerned with the future of the students and the future status of the Imperial College of Science—matters of supreme importance not merely to themselves and those who would succeed them, but indirectly to the whole of the British Empire. The legitimate demand of the day, especially prominent in the City of London, was that there should be established a very close relationship between scientific research and industry. Furthermore, many of them held the view that no honor was too great, no distinction too high, for students who, by the application of scientific principles to the problems of daily life, increased the wealth and power of the British Empire, and added to the grand total of this world's happiness. Industrial concerns in London were strongly in favor of giving full encouragement and the highest recognition to men and women who devoted their lives to scientific and industrial research. They could rest assured that this college had been, and was still, the principal source of supply of technologists to those in charge of industry in the City of London.

Mr H. Burnie, chairman of the organizing Committee, reported that the Royal School of Mines Old Students' Association had passed a resolution giving support to the proposal. The chairman then formally moved that the petition be signed and forwarded to the governors of the college. Captain E. G. Lawford, in seconding the resolution, declared that the time had come when it was absolutely impossible for the Imperial College to carry on exactly as it was now. The reconstruction of London University had been approved, and would be undertaken very shortly; and in that reconstruction the Imperial College was bound to become involved. This would be disastrous to the college. The Imperial College was now standing on the brink of an upheaval, and unless a very strong line was taken it was bound to lose its own identity. By absorption, the college would lose control of its own funds—and of its syllabus, and of its identity as the Imperial College.

CLASSIFICATION OF LANDS BY THE GEOLOGICAL SURVEY

Secretary Lane reports that definite progress was made in the month of January, 1919, in the classification of lands effected by the Geological Survey of the Interior Department. The principal action affecting mineral lands was the restoration of somewhat more than 773,000 acres in North Dakota. These lands lie in the lignite area of that state and the government still owns coal in only a relatively small proportion of those restored. As to this proportion, the restoration will permit the purchase of these lands or of the coal within them at prices of $10 and $20 per acre.

A portion of the results of last summer's field work in the examination of the question of irrigability of western lands appears in orders approved during January which designated somewhat more than 1,000,000 acres for entry under the so-called enlarged-homestead act, the principal requirement under this act being that the lands shall be nonirrigable. The areas designated by states appear in the following table:

	Acres
Idaho	10,840
Montana	17,876
Oregon	39,720
South Dakota	211,331
Wyoming	726,131
Total	1,005,898

Similar progress was manifested during January in rendering lands available for entry in tracts of 640 acres each under the stock-raising homestead law. Somewhat more than 940,000 acres were designated during the month under this act. These lands are distributed as indicated in the table below:

	Acres
Arizona	47,020
California	97,332
Colorado	91,097
Kansas	17,100
New Mexico	392,320
Oklahoma	4,998
Oregon	57,500
Wyoming	234,050
Total	941,417

The total area thus far designated by the secretary for entry under the stockraising homestead act is now a little more than 13,500,000 acres. This work has been accomplished in the slightly more than 19 months since Congress first made provision for the administration of the stock-raising homestead act. After that provision was made, the force for the classifications had to be organized, the principles of classification determined, the lands examined, decisions reached as to their character, and the orders of designation issued.

CIVIL SERVICE EXAMINATIONS

The United States Civil Service Commission announces open competitive examinations for scientific positions as follows:

Department of the Interior: Geological Survey: Geologic aid, March 12–13, $90 a month to $1,440 a year; assistant geologist, March 12–13, $1,500 to $1,800 a year. Indian Service: Oil and gas inspector, March 25, $1,500 to $1,800 a year. Public Health Service; Statistical clerk, March 26, $1,000 to $1,800 a year. Patent Office: Assistant ex-

aminer, March 26–28, May 21–23, July 23–25, $1,500 a year.

Department of Agriculture: Assistant horticulturist, March 18, $1,800 to $2,200 a year; superintendent of road construction, March 25, $150 to $250 a month; assistant dairy husbandman, March 26, $1,500 to $1,740 a year; scientific assistant, April 22–23, $900 to $1,800 a year; United States Game Warden, May 7, $1,500 a year; physical laboratory helper, March 12, April 9, May 7, and June 4, $600 to $900 a year.

Department of Commerce: Physical laboratory helper, March 12, April 9, May 7, and June 4, $600 to $900 a year; Bureau of Fisheries: Apprentice fish culturist, March 12, April 9, May 7, and June 4, $600 to $960 a year. Coast and Geodetic Survey: Marine engineer, April 1, $100 to $140 a month.

Interdepartmental Social Hygiene Board: Supervisor, social hygiene (open to women only), March 25, $2,000 to $2,500 a year; assistant special agent, social hygiene (open to women only), March 25, $600 to $1,000 a year.

National Advisory Committee for Aeronautics: Chief physicist, qualified in aeronautics, March 25, $3,000 a year; physicist, March 25, $2,100 a year.

Full information and application blanks may be obtained by addressing the United States Civil Service Commission at Washington, D. C., or the civil-service district secretary at Boston, New York, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, St. Louis, New Orleans, Seattle, or San Francisco.

THE COMMITTEE ON GRANTS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE Committee on Grants was appointed by the council of the association to distribute the annual appropriation for research. It is intended that encouragement and support be given to investigations in any of the fields covered by the activities of the association. For the current year the sum of $4,000 has already been assigned, and will be available on April 1. Preference will be given to applications in which definite statement is made of the nature of the problem, the main item of expense, and the probable time for completion of the research. Recipients of grants are expected to agree to the following conditions:

1. The work as outlined will be begun in the near future and efforts will be made to complete it at as early a date as possible.

2. A report will be made to the secretary of the committee on the completion and publication of the work, and in December of each year until the work is completed. The reports will include a financial statement with vouchers for the larger items.

3. In the publication of the results the grant from the Research Fund of the American Association for the Advancement of Science will be acknowledged.

The membership of the committee for the year 1919 is: Henry Crew, chairman; N. L. Britton, W. B. Cannon, J. McK. Cattell, R. T. Chamberlin, L. I. Dublin, G. N. Lewis, G. H. Parker, Joel Stebbins, secretary.

All applications for grants should be received not later than March 15 by the secretary of the committee, who will see that they are properly considered.

JOEL STEBBINS,
Secretary
UNIVERSITY OF ILLINOIS OBSERVATORY,
URBANA, ILL.

SCIENTIFIC NOTES AND NEWS

PROFESSOR EDWARD L. NICHOLS, who will reach the age of sixty-five, on September 14, has tendered his resignation of the professorship of physics, at Cornell University, which he has held since 1887.

THE Paris Academy of Sciences has elected Major General Sir David Bruce, F.R.S., to be a foreign correspondent in the section of medicine and surgery.

COLONEL VICTOR C. VAUGHAN, dean of the medical school, of the University of Michigan, will return to the university and resume his duties for the second semester. Colonel Vaughan has been in Washington since the entrance of the United States into the war,

serving with the Medical Corps of the U. S. Army.

Dr. P. W. Bridgman has returned from the naval experimental station at New London, Connecticut, to his work in the Jefferson Physical Laboratory, Harvard University.

Dr. Edgar Buckingham, who has been associated with the work of the scientific attaché of the American Embassy in Rome, has returned to Washington.

Professor Moses Gomberg, of the department of chemistry of the University of Michigan, who has been serving in the Ordnance Department since early in the war, has returned to the university to assume his former work. Professor Gomberg, while in the service, held the rank of major.

Dr. George H. A. Clowes, formerly of the Gratwick Research Laboratory at Buffalo, N. Y., and lately engaged in research at the American University Experiment Station of the Chemical Warfare Service on the physiological effects of war gases, left Washington in January to take up biochemical research at the laboratories of Eli Lilly & Company, of Indianapolis, Indiana.

Dr. Asher F. Shupp has resigned his position as research chemist on dyestuffs for E. I. duPont de Nemours and Company, and is now working on an industrial fellowship at the Mellon Institute.

Mr. Seth S. Walker, formerly associate chemist of the Florida Agricultural Experiment Station and more recently chemist to the Florida Fruit Products Company, has been appointed soil chemist for the Louisiana Agricultural Experiment Station at Baton Rouge.

Henry Allen Gleason, associate professor of botany and director of the botanical gardens at the University of Michigan, has accepted a position as first assistant in the New York Botanical Gardens.

Professor W. W. Rowlee, of Cornell University, has returned to Ithaca after an absence of several months in Central America. There, as a specialist in timber, he was investigating the growth and availability of certain woods of possible use in airplanes and other implements of war.

Dr. William H. Nichols, president of the American Chemical Society, has announced the appointment of the committee to estimate the cost and outline policies for the proposed National Institute of Drug Research to which reference has already been made in Science. The committee consists of Dr. John J. Abel, the Johns Hopkins University; Dr. Raymond F. Bacon, director of the Mellon Institute for Industrial Research; Dr. Frank R. Eldred, research chemist; Dr. Charles H. Herty, editor of the *Journal of Industrial and Engineering Chemistry, chairman;* Dr. Reid Hunt, Harvard University, Dr. Treat B. Johnson, Yale University; Dr. P. A. Levene, Rockefeller Institute, and F. O. Taylor, chairman of the Pharmaceutical Division, American Chemical Society.

Appointment of a committee to study government records of the influenza epidemic has been announced by the Bureau of the Census. Dr. William H. Davis is chairman, the members including C. S. Sloane, representing the Bureau of Census; Dr. Wade H. Frost and Edgar Sydenstricker, of the Public Health Service; Colonel D. C. Howard, Colonel F. F. Russell, and Lieutenant-Colonel A. G. Love, United States Army; Lieutenant-Commander J. R. Phelps and Surgeon Carroll Fox, United States Navy.

There was organized at Washington, D. C., on February 14, an association to be known as the Agricultural History Society. The officers of the society are: Dr. Rodney H. True, Bureau of Plant Industry, Washington, D. C., *president;* Professor Wm. J. Trimble, Agricultural College, N. Dak., *vice-president;* Lyman Carrier, Bureau of Plant Industry, Washington, D. C., *secretary-treasurer;* Professor R. W. Kelsey, Haverford, Penna., and O. C. Stine, Office of Farm Management, Washington, D. C., *members of the executive committee.* The object of the society is "to stimulate interest, promote study and facilitate publication of researches in agricultural history." Any one interested in this subject, who pays

the dues of $1.00 per year, is eligible for membership and should write to the secretary-treasurer.

WE learn from *Nature* that a course of six public lectures on "Physiology and National Needs," arranged in conjunction with the Imperial Studies Committee of the University of London, is being delivered at King's College, Strand, W. C. The first lecture was by Professor W. D. Halliburton on February 5 on "Physiology and the Food Problem," and succeeding lecturers will be Dr. M. S. Pembrey, Professor F. G. Hopkins, Professor A. Harden, Professor D. Noel Paton, and Professor A. Dendy. On February 4, Professor J. T. MacGregor-Morris delivered the first of a course of two lectures at the Royal Institution on "Study of Electric Arcs and their Applications." On February 6, Dr. W. Wilson gave the first of two lectures on the movements of the sun, earth, and moon, illustrated by a new astronomical model. The Friday evening discourse on February 7 was delivered by Professor J. G. Adami on medical research in its relationship to the war; and on February 14 by Professor Cargill G. Knott on earthquake waves and the interior of the earth.

THE Hunterian Oration was delivered before the Royal College of Surgeons of England, on February 14, by Major General Sir Anthony A. Bowlby.

DR. JOHN WALLACE BAIRD, professor of experimental psychology in Clark University, last year president of the American Psychological Association, died on February 2, at the age of forty-five years.

CAPTAIN THEODORE DE BOOY, the archeologist and explorer, died at his home in Yonkers, on February 18. Captain de Booy was born in Holland, thirty-six years ago, and came to the United States in 1906. He was in charge of the West Indian archeological work of the Museum of the American Indian in New York City.

MR. M. N. STRAUGHN, formerly of the Bureau of Chemistry in Washington, died in Porto Rico on January 9, 1919.

THE death of Sir James Sawyer, formerly professor of pathology and medicine at Birmingham, on January 27, in his seventy-fifth year, is announced.

FIGURES are printed to the effect that the 1,200 casualty lists published by the German army and navy contained the names of 1,158 physicians reported slightly wounded, 332 severely wounded, 663 killed, 422 as succumbing to disease, 212 taken prisoner, seventy-two missing and one killed by gas.

THE U. S. Civil Service Commission announces for March 12, an examination for observer and meteorologists, for men only. Vacancies occurring in the Weather Bureau, Department of Agriculture, for duty in Washington, D. C., or in the field, at entrance salaries ranging from $1,260 to $1,800 a year, will be filled from this examination.

THE Grasselli Chemical Company, of Cleveland, Ohio, has announced its intention to found a medal to be awarded annually by the New York Section of the Society of Chemical Industry for the thesis presented before the section which shall, in the opinion of the medal committee, offer the most useful suggestions in applied chemistry.

PROFESSOR J. ROTGANS, of Amsterdam, was given a sum of money, collected by subscription, on the recent twenty-fifth anniversary of his entering on the practise of medicine. He has donated this sum as a nucleus of a fund for cancer research in the Netherlands.

THE sum of £3,000 has been given by Mr. G. T. Hawkins, of Northampton, towards the building and equipment of a pathological laboratory at the Northampton General Hospital.

THE Goodrich conservation bill, which has been the center of controversy in two sessions of the Illinois legislature, has been reported favorably out of committee in the house. The bill calls for a bi-partisan commission of four to take over the work of the state geologist, state entomologist, fish and game commission, state board of forestry, and state park board. It also provides for a director who

shall have supervision of the work of conservation. The house amended the bill by authorizing the Illinois Academy of Science to suggest candidates for membership on the board.

The Bellevue Hospital unit, numbering three hundred physicians, nurses and enlisted men, attached to Base Hospital No. 1, at Vichy, near Paris, has received orders to prepare to sail and probably will return at once. Major John H. Wyckoff, secretary of the medical faculty of the New York University and Bellevue Hospital Medical College, who was formerly one of the heads of the American hospital, has received a letter from Lieutenant Colonel Arthur M. Wright, commander of the hospital, in which he said his organization had been relieved and that the hospital had been taken over by an evacuation hospital personnel. The unit is composed of many well-known New York physicians and nurses from Bellevue Hospital and 200 enlisted men who were recruited at the Medical College for overseas duty. It set sail for France on February 18, 1918, and has since handled a large number of the American Army wounded cases. Base Hospital No. 1 was one of the largest near Paris and received mostly American cases. The organization was prepared for 500 patients but at one time cared for as many as 3,200 cases. The unit includes twenty-six physicians, sixty-five nurses and 200 enlisted men.

UNIVERSITY AND EDUCATIONAL NEWS

At the commemoration day exercises of the Johns Hopkins University on February 22, Dr. William H. Welch, who presided, announced that a sum of approximately $400,000 had been given anonymously for the erection of a building at the Johns Hopkins Hospital to serve as a woman's clinic.

The present applied science building of the University of Toronto, which has been condemned, will be removed and in its place will be erected a large engineering building. The chemistry and mining buildings will be enlarged and will accommodate the department of electrical engineering and applied mechanics.

The farmers of New Jersey, through their representatives at the annual state agricultural convention at the State Capitol at Trenton, have requested the Legislature to provide an appropriation for a horticultural building at the State College of Agriculture at New Brunswick.

The gift to the University of Caifornia Museum of valuable textiles left by the E. E. Caswell Estate and presented to the university through Regent Phoebe A. Hearst, was acknowledged by the board of regents at the recent monthly meeting in San Francisco. The textiles have been loaned to the Palace of Fine Arts for exhibition.

In the reorganization on the basis of departments at Yale University, Professor B. B. Boltwood has been elected chairman of the university department of chemistry.

Professor Guy West Wilson has been appointed associate botanist and plant pathologist in Clemson College, South Carolina.

From *Nature* we learn that Dr. R. M. Cavan, of the chemistry department of University College, Nottingham, has been appointed principal of the Technical College, Darlington, and Mr. W. H. Watson, of the chemistry department of the Northern Polytechnic Institute, has been appointed vice-principal and head of the chemistry and natural science department of the Municipal College, Portsmouth.

DISCUSSION AND CORRESPONDENCE

ELECTRO-THERMO-REGULATOR FOR WATER BATHS

I have read with interest an article entitled "Electro-Thermo-Regulator for Water Baths," by Mr. Charles H. Otis, of the Western Reserve University, which appeared in Science, of October 25, 1918.

Thermostatic control of temperatures for various scientific and technical purposes has become increasingly important in recent years, and we have, therefore, developed an extremely sensitive bi-metallic metal of homogeneous form adapted to such applications.

This metal has already been applied in a number of cases to commercial devices for this purpose, one of which is being manufactured at the present time by the Central Scientific Company.

Any increase of sensitiveness, or any reasonable amount of force on a given temperature change may be obtained by manipulation of the length, width and thickness of the metal. By using very thin sections extreme sensitivity may be obtained, deflections as great as one fourth inch per degree Centigrade being possible. On the other hand, by materially increasing the thickness great force can be created, in one instance approximately one fourth pound per degree Centigrade.

On account of the process of manufacture employed, the danger of permanent set has been practically eliminated, so long as the metal is not overstrained.

G. E. Thermostatic Metal, as it is known to the trade, is produced regularly in thicknesses from .015 to .25 inch; widths up to 6 inches and lengths up to 36 inches. In special cases it may be obtained in thickness as small as .005.

I feel sure that a knowledge of the characteristics and adaptability of this material will enable many experimenters to solve problems of temperature control or indication with much greater ease and accuracy than heretofore.

CHESTER I. HALL

GENERAL ELECTRIC COMPANY,
FORT WAYNE, IND.

COMMON NUMERALS

THE origin of our common number symbols has never been clearly established, but until recently all writers on this subject agreed that these symbols were transmitted to Europe by the Arabs who had obtained them from India. This is the view expressed in the general encyclopedias and in our mathematical histories which consider this question. For example, in the eleventh edition of the *Britannica* under the word "numeral" there appears the following statement:

> The areas designated by states appear in the following table:
>
> **What is quite certain is that our present decimal system, in its complete form, with the zero which enables us to do without the ruled columns of the abacus, is of Indian origin. From the Indians it passed to the Arabians, probably along with the astronomical tables brought to Bagdad by an Indian ambassador in 773 A.D.**

In view of these facts it is very interesting to note that during recent years available data relating to the origin of our common number symbols have been carefuly reexamined by Carra de Vaux, who published in volume 21 of *Scientia* a brief summary of his results. Among the most surprising of these results are the following: Our common number symbols originated in Europe and from there were transmitted to the Persians. Both India and Arabia received them from Persia, so that the common term *Hindu-Arabic numerals* is decidedly misleading. The common numerals did not come from letters of the alphabet, but were formed directly for the purpose of representing numbers.

It does not appear likely that all of these conclusions reached by Carra de Vaux, who has made an extensive study of the intellectual life among the Mohammedans, will be at once accepted, but they tend to exhibit the weak foundation upon which the history of our common numerals has thus far rested. In fact, the nature of this question is such that it seems likely that general agreement as regards the origin of our numerals can result only from that attitude of mind (known as philosophy) which would rather accept as facts what can not be proved than acknowledge ignorance. Conclusions similar to those of Carra de Vaux were also expressed in a Russian work by N. Bubnow (1908), which was translated into German and published in Berlin in 1914.

G. A. MILLER

PSYCHOLOGICAL RESEARCH FOR AVIATORS

TO THE EDITOR OF SCIENCE: In his article on "Psychological Research for Aviators" in SCIENCE of January 24 Dr. Dunlap inadvertently neglects some of the most important

work on tests of flying ability. Burtt, Troland and Miles were working at Cambridge in the spring and summer of 1917, and the work of Captain Henmon at Kelly Field No. 2 in the spring of 1918 was contemporaneous with and under the same authorization as that of Professor Stratton. A prophesy based upon Captain Henmon's results was of notable influence in leading the director of military aeronautics to authorize tests of ability to learn to fly in connection with the regular work of the examining boards.

E. L. Thorndike

Teachers College,
Columbia University

To the Editor of Science: Professor Thorndike has called my attention to the fact that in my article on psychological research for aviators in Science of January 24, I made no reference to the work of Burtt, Troland and Miles, and the work of Henmon, which was reported in relatively full detail in Thorndike's article in the preceding (January 17) number of Science. A footnote referring to Thorndike's report should have been inserted in my article to prevent the supposition that I was covering the work of all investigators. No detailed information concerning the work of Burtt, Troland and Miles was given me until Thorndike's address appeared, hence I should not attempt to describe it. The work started by Stratton, and subsequently developed by Stratton and Henmon, should, as I stated in my article, be reported by Stratton.

I may add that important work in aviation was done by a number of psychologists not mentioned by either Thorndike or myself: Maxfield for instance conducted a valuable piece of research which was, I believe, reported to the psychology committee.

I trust it will be understood that my report was not intended as a comprehensive account of all work in aviation by psychologists, and that if I am able, later, to give a full account of all work done under my control, I shall not attempt to relate the activities of other psychologists except in so far as those activities had direct effects in facilitating or interfering with my own work.

Knight Dunlap

QUOTATIONS

THE HISTORY OF INFLUENZA

Although the term influenza was not formally adopted by the Royal College of Physicians of London till 1782, the disease was known to Hippocrates and other ancient physicians, and a formidable list of epidemics in various parts of the world between the years 1173 and 1875 is given by Hirsch in his "Handbook of Geographical and Historical Pathology." Records of outbreaks in this country between 1510 and 1837 were collected by Theophilus Thompson and published by the Sydenham Society in 1852; they were brought down to 1891 by E. Symes Thompson. Many physicians, among them such men as Sydenham (1675), Huxham of Plymouth (1729), Arbuthnot (1732), Sir George Baker (1762), and John Fothergill (1775) had written about the disease from the clinical point of view, but Immanuel Kant, who, like Bacon, took all learning for his province and was specially interested in medicine, was one of the first to direct attention to its epidemiology. Towards the end of the eighteenth century influenza swept over nearly the whole world. It reached Siberia and Russia, China and India, in the autumn of 1781, and in the following December and February it invaded successively Finland, Germany, Denmark, Sweden, England, Scotland, the Netherlands, France, Italy, and Spain. Kant, in a "Notice to Physicians" published in the lay press of Königsberg on April 18, 1782, considered the disease in its relation to physical geography. He expressed the opinion that it was spread not only by atmospheric conditions but by infection conveyed by insects. The paths of communication between Europe and other parts of the world by sea and by caravan were, he thought, the means of conveyance of many diseases, and he found reason to believe that the Russian-trade route to China by land had brought several kinds of harmful insects from the farthest East. The epidemic of 1781–82 spread along the Baltic coast till it reached Königsberg; thence it travelled to Danzig and Prussia. Kant's interest in influenza is shown

by the frequency with which he refers to the subject. With the object of procuring further information he sent his "notice" to Russia, and from Baron von Asch, surgeon in the Russian army, he learned that in January, February, and March, 1782, a disease described as "febris catarrhalis epidemica benigna" prevailed in the Russian capital. It originated in eastern Siberia, on the Chinese frontier, and spread through the whole of Russia. —*The British Medical Journal.*

SCIENTIFIC BOOKS

A Text-book of Precious Stones. By FRANK B. WADE, B.S. Published by G. P. Putnam's Sons, 1918. 8vo, pp. xiii + 318. Illustrated.

Those who are familiar with the work on "Diamonds" by the same author will find the present book characterized by similarly attractive features. The style is clear and precise and readability and practicality are afforded by examples drawn from the writer's own experience.

The book will appeal to the amateur rather than the professional student, but this is probably the intention of the author. His experience as a teacher has doubtless aided him in presenting the subject in a systematic and easily assimilable manner. The physical properties of gems are treated under the various subdivisions of refraction, absorption and dichroism, specific gravity, luster, hardness, and color, each to the extent of one or more chapters, and numerous practical details are given in the chapters on testing, cutting, occurrence and imitation of gems. The chapter on "tariff laws" affords useful information not readily found elsewhere and the bibliography of the subject of gems is the most complete and satisfactory for the purposes of the general reader that the reviewer remembers to have seen. The book is not extensively illustrated, a few text figures from line drawings comprising all the pictures that are provided.

Besides its usefulness for general reading, the title of the book and its systematic plan suggest that it could be employed for more formal instruction. The wide distribution of gems in Nature and their possession in some form in almost every home, make it probable that they could be used more extensively than is now the case as a basis for school study.

The reviewer finds little to criticize adversely in the book beyond the occasional use of the term "gemology." While this term might be generally understood to refer to the science of of gems, it is incorrectly formed for this purpose and in reality has quite a different meaning. The Greeks seem to have had no single term for distinguishing objects used for the purposes for which we use gems, but indicated things of value by the adjective τίνιος. Prefixing this adjective to λίθος, stone, the term *tiniolithology* can be obtained, which is at least a word properly formed to indicate the science of gems.

OLIVER C. FARRINGTON
FIELD MUSEUM OF NATURAL HISTORY

SPECIAL ARTICLES

PINK ROOT OF ONIONS

IN 1915 Professor F. W. Mally called the writer's attention to a very serious disease of onions in Webb County, Texas, and locally known as pink root. Investigations were begun on this disease with Professor Mally, who cooperated in the field experiments and offered valuable assistance in many ways. A search in literature showed that there were no records that could be found, where mention was made of this new plant trouble. From conversation with Professor Mally I was told that Professor W. M. Gilbert, of the United States Department of Agriculture, had at one time worked on this disease and also published an account of the same. However, a letter received from Professor Gilbert dated May 15, 1918, says as follows: "So far as I know there are no publications on this disease, as I did not do enough work on it to secure results for publication and have not had the opportunity to study it very recently." The writer was the first to report on this disease in 1917.[1]

[1] Taubenhaus, J. J., "Pink Root, a New Disease of Onions in Texas," Phytopath. 7: 59, 1917 (abstract).

The symptoms of this trouble are very striking. Affected roots turn yellowish, then pink and dry up. The disease is confined to the roots only and not to the bulb. As fast as the old roots are affected new ones are produced, these in turn becoming diseased. In the end, the bulb spends all its energies in producing new roots which in turn become affected, thus failing to attain the commercial standard. Diseased bulbs remain dwarfed and small to the end of the season, although apparently sound in every other way. The average annual loss from this disease in Webb County may be estimated at forty per cent.

Careful investigations in the laboratory of the Texas Experiment Station revealed the fact that the disease was caused by an apparently new pathogenic organism, the name of which is proposed to be *Fusarium malli,* n. sp. Over one thousand plate cultures were made from diseased material and in nearly every case a pure culture of the above organism was obtained. Moreover in planting healthy onion sets in both sterilized sand or soil in which a pure culture of the *Fusarium* fungus was worked in, the disease in each case could readily be reproduced. The symptoms on the artificially infected plants were in every respect identical with those of infected plants naturally found in the field. The checks remained free, proving that *Fusarium malli* Taub. is the cause of pink root.

Numerous laboratory experiments, which were duplicated in the field have yielded results which are briefly summarized as follows:

1. The disease is carried with infected sets.

2. The disease is carried over from year to year in the soil. Short term rotations with other crops than onions on pink root lands do not starve out the pink root fungus.

3. Pink root attacks not only the onions but also the garlic and the shallot. It does not seem to attack any other of the liliaceous plants.

4 Steam sterilizing will kill the fungus in the soil. Formaldehyde at the rate of one pint to twenty gallons of water, per square foot will also rid the soil of the causal organism.

5. Applications of lime will not rid the soil from pink root.

6. In infected soils liberally fertilized, especially where quickly available plant food is applied, together with proper cultural management, the crop can be nursed to produce fairly normal yields. In this case the proper fertilizer merely stimulates the bulbs in producing new roots faster than the disease can destroy them.

7. Fertilizers rich in nitrogen and organic matter are especially valuable for use in soils infected with the pink root.

8. Healthy sets when planted on diseased soils will contract the disease. Likewise, diseased sets planted on healthy soils will also yield diseased bulbs.

Numerous experiments both in the field and in the laboratory are still in progress and as soon as these are completed a bulletin will be published by the Texas Experiment Station giving a full description of the causal organism and results of the experiments.

J. J. Taubenhaus
College Station, Texas

A CHROMOSOME DIFFERENCE BETWEEN THE SEXES OF SPHÆROCARPOS TEXANUS

The chromosome group in the cells of the female gametophyte of *Sphærocarpos texanus* is characterized by one large element greater in length and in thickness than any of the other chromosomes in the group. This large element does not appear in the chromosome group of the male gametophyte, but instead there is a small chromosome commonly nearly spherical in form, and unlike anything found in the female. The other chromosomes in the cells of both sexes vary in length. They have the form of rods, usually curved. The chromosome number for each sex seems to be eight. In the cells of the female, seven of the eight are similar respectively to seven of the male. The eighth chromosome of the female (the largest one) seems to correspond to the small chromosome of the male. The condition as to the chromosomes of the gametophytes in

this species is thus similar to that described by Allen[1] for *S. Donnellii.*

MARTHA A. SCHACKE
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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE —SECTION M—AGRICULTURE

THE program of the Baltimore meeting of the Section of Agriculture was considerably interfered with by sickness and absence in Europe on war service. A single session was held on the afternoon of December 27, 1918. The retiring vice-president, Dr. H. J. Waters, was prevented by sickness from attending the meeting and delivering his address, the subject of which as announced was "The Farmers' Gain from the War."

In the absence of the vice-president, Dr. H. P. Armsby, who is with the Interallied Food Commission in Europe, Dr. A. F. Woods presided over the session. This was devoted to the agricultural situation in Europe as viewed by members of the American Agricultural Commission which spent several months in Great Britain, France and Italy in the early fall.

Describing "Some Impressions of the Effect of War on Agriculture in England and France," Dr. W. A. Taylor reviewed the highly successful efforts in England to stimulate production resulting in 1918 in an increased area in cereals of 32 per cent. and in potatoes of 45 per cent. over the ten-year pre-war average. This increase was not due to the existence of an actual shortage, for apparently at no time was there less than three months supply of wheat in sight, or to the expectation of large profits on the part of farmers, but rather to apprehension that conditions might grow worse and to the necessity of saving tonnage. The organization through which the increase was accomplished and the measures put in force under the Defense of the Realm Act were effective and often revolutionary. Local production campaigns were in the hands of agricultural executive committees, who were authorized when persuasion failed to take drastic action, even to dispossessing tenants and breaking up and operating idle land at the expense of the owners. Restrictions on the crops to be grown, their sale and use were extensive and far exceeded anything hinted at in this country. A reform of much importance was the putting into operation of a seed control measure similar to that maintained in several of the states in this country, which yielded such beneficial results that it is expected to be permanent. The government also controlled the price of certain seeds, as seed potatoes, and to avoid local shortages purchased nearly a million dollars' worth of seed potatoes for sale to commercial growers and allotment holders.

While tenant farmers profited by good prices and reduced competition, land owners were prevented by law from raising their rents during the war despite increased taxes and other expenses. In consequence the sales of land exceed those for a generation, and include not only large holdings but relatively small farms, mostly land not operated by the owners. Purchasers are mainly of the tenant farmer class, and no marked movement of population from the city to the land was noted. There was much evidence of greatly aroused interest in agricultural research, instruction and extension teaching which is expected to bear fruit in increased facilities.

In sharp contrast to Great Britain, France showed abundant evidence of decreased crop production, as was to be expected. In 1917 the production of cereals fell to 53 per cent. of the pre-war average. A return to nearly 75 per cent. in 1918 was "accomplished through most strenuous and exhausting effort and to a considerable extent at the expense of future crops through the breaking up of the best crop rotation practise."

The reconstruction problems in France were described as complicated, one of the most difficult being the remanning of the land. Of the 250,000 farmers of the devastated region it is estimated that perhaps 100,000 may return to their holdings. Much of the land consists of small parcels, the holdings of an

[1] Allen, C. E., "A Chromosome Difference Correlated with Sex Differences in *Sphærocarpos*, SCIENCE, N. S., 46: 466–467, 1917.

owner being more or less scattered, which points to the importance of consolidating these tracts into compact units capable of more economic management. The question of whether the destroyed rural villages should be rebuilt on their old sites rather than to relocate them more advantageously is another matter of considerable importance. A rapidly growing sentiment was noted for the restoration of the devastated region by the invaders, rather than the mere payment of financial indemnity. The French government has already provided a credit of approximately sixty million dollars, from which allowances are being made to farmers who are ready to return to their land. For the most part the restoration of the fields did not impress the commission as being as appalling as might be expected, and was compared with the reclamation of stump land in this country.

Speaking of the Live Stock Conditions in Europe, Mr. George M. Rommel reported that European farmers had been quite successful in maintaining their supplies of breeding animals. Although they have suffered from a shortage of feed and some inroads have been made on certain kinds of stock by the military demands, the number of cows and heifers in Great Britain is fully as large now as before the war, and this is true of cattle generally. The milk supply has been reduced on account of the shortage of concentrated feed, and this has also cut down the number of pigs quite extensively. There was also a small falling off in sheep.

In France there are about two million less cattle than before the war, principally due to invasion. Since the close of 1914 the decline in number of cattle has been less than 2 per cent., the young stock having increased. A similar increase also applies to Italy. Sheep have declined nearly 40 per cent., due largely to labor shortage, and hogs somewhat more due to a lack of concentrated feed. The shortage of milk in France is more serious than in Great Britain. The heavy demand for horses for military purposes has reduced the available number by about a million. The record of the Percheron horses in the British army has excited a good deal of interest among farmers and breeders in England and led to efforts to establish this breed of horses in that country.

Prices of breeding stock were reported as extremely high in both France and England. Breeders are anticipating a good trade after the war and have kept their stocks intact at great expense. Not much demand for live stock from the United States was looked for in the immediate future, although dairy cows may be needed and after the war American horses will doubtless be required in Europe, mainly of the commercial grades.

Mr. E. C. Chilcott, who went to the French colonies at the instance of the French High Commission, was to have described the agricultural conditions found there, especially in Algeria, but was detained by illness.

At the business meeting Dr. A. F. Woods, president of the Maryland Agricultural College, was nominated vice-president, and Dr. J. G. Lipman, director of the New Jersey Experiment Stations, secretary of the section, and these nominations were subsequently confirmed by the general committee of the association. Other officers for the year were elected as follows: Member of the general committee of the association, Mr. George M. Rommel, U. S. Department of Agriculture; member of the council of the association, Dr. A. C. True, U. S. Department of Agriculture; member of the sectional committee (for five years), Professor C. P. Gillette, director of the Colorado Experiment Station.

E. W. Allen,
Secretary

SCIENCE

A Weekly Journal devoted to the Advancement of Science, publishing the official notices and proceedings of the American Association for the Advancement of Science

Published every Friday by

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.
NEW YORK, N. Y.

Entered in the post-office at Lancaster, Pa., as second class matter